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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Flame Photometers

We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY, London, a British Authority, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to flame photometers, and is particularly, but not exclusively, concerned with photometers suitable for the testing of high efficiency air filters.

When testing filters, a cloud of sodium chloride particles obtained by solution spraying and evaporation to dryness in the air stream passes into the filter. A flame photometer measures the mass concentration of salt in samples from the air flow upstream and downstream of the filter and the ratio of these concentrations expressed as a percentage is the penetration of the filter. The salt present in the air flow causes a proportional yellow colouration in the flame in the photometer and a measurement of the light intensity of the flame indicates the mass concentration of salt in the air.

In the conventional forms of sodium flame photometers, hydrogen, under controlled pressure, is supplied to a suitable burner and the flame viewed through a sodium interference filter and appropriate neutral density filters by a photomultiplier to provide a deflection on a suitable galvanometer. The flame is surrounded by a glass chimney and the air for combustion and/or sodium chloride laden air for analysis is supplied by convection up the chimney. Difficulties can arise during operation of the flame photometer due to the inherent dangers in the use of hydrogen, the necessity of using neutral density filters to avoid overloading the photomultiplier and the necessary variation of such filters to suit the work in hand. The calibration of the instrument can prove troublesome and the high voltage power required for the photomultiplier is disadvantageous in practice. Furthermore the use of convection to provide air flow in the chimney leads to uncertainties as to flow rates and concentrations since the convection depends upon several factors which can vary without indication i.e. flow rate and pressures in the supply ducts to the chimney and since in operation, a salt laden air surrounds the burner, the external surfaces of the burner can easily become contaminated by a salt deposit, requiring time consuming cleaning or renewal operations.

According to the invention a flame photometer comprises a hollow burner arranged to project into a transparent chimney, spaced inner and outer casings surrounding the chimney, means for supplying metered quantities of air and a combustible gas to the burner, means for supplying coolant to the space between the inner and outer casings, means to selectively introduce to said flame with said air and combustible gas a metered quantity of a sample of air containing a substance the quantity of which is to be measured, the substance when introduced to said flame causing the flame to emit light of one or more characteristic spectral lines, a lens adjacent the chimney, a photo-electric cell co-operating with said lens to measure the light intensity of the flame through said chimney and optical filter means disposed between the lens and said photo-electric cell for selectively passing one or more of said spectral lines to said light sensitive cell to provide an indication of the quantity of said substance in the sample of air.

Preferably light guide means, formed from a solid transparent material of frusto conical shape is provided between the lens and the photo electric cell.

The burner preferably comprises a hollow flat topped cylinder apertured in its upper surface and the air, combustible gas, and air containing said substance are supplied through ducts to a mixing chamber connected to the interior of said burner.

[*Prio*

To enable the nature of the invention to be more readily understood, one embodiment of the invention will now be described, by way of example only, with reference to the drawing accompanying the Provisional Specification. The drawing shows a diagrammatic vertical mid-sectional view of a flame photometer.

Referring to the drawing the flame photometer comprises a hollow burner 1 projecting into a rectangular glass chimney 2, inner and outer metal casing 3 and 4 surrounding the chimney, means for supplying metered quantities of air and combustible gas to the interior of the burner and means for viewing and measuring the intensity of the flame through said chimney.

The burner 1 comprises a hollow flat topped cylinder having a plurality of apertures 5 arranged in two lines on its top surface and a wire gauze 6 located internally below the holes. The burner is centrally spigotted into a hollow base member 7 and the lower end of the glass chimney is sealed to the burner. The inner and outer casings 3 and 4 are secured to the base to provide concentric annular spaces 8 and 9 around the chimney. Inner casing 3 is open at the top and extends above the glass chimney and outer casing 4 extends above casing 3 and is provided with a light trap 10 at its upper end.

The interior of base member 7 is connected to an air/gas mixing chamber 11 into which two supply ducts 12 and 13 supply air and combustible gas in metered quantities. The metering arrangements include conventional gas flow measuring arrangements 14 and 15. A filter 16 under test is shown connected to duct 12 and clean air or a sodium salt laden air can be passed through the filter and supply duct 12. It will be appreciated that when in operation a quick acting valve (not shown) is provided to enable a change over, from sodium salt laden air to clean air or vice versa, to be made without upsetting the flame.

The flame is viewed through a lens 17, located in the wall of the inner casing 3, by a cadmium sulphide cell 18. Cell 18 is located in an extension portion 19 attached to the outer casing 4. Since cadmium sulphide cells are heat sensitive the cell is located in an end wall 20 of extension portion 19 and a light guide 21 interposed between the cell and the lens 17. The light guide 21, supported in a housing 22, comprises a polished cone of transparent material, for example, glass or a clear acrylic material. The cone gathers light from the flame at 2 inches diameter and concentrates it on to the cell at 3/4 inch diameter about 6 inches away. A glass heat filter 23 and a sodium interference filter 24 are fitted between the lens 17 and the cone.

The instrument is cooled by passing a flow of air through the annular space 9 from a suitable pressurised supply. The coolant flows via a supply duct 25 into extension portion 19, between filter 23 and 24 and into the annular space 9 via a ring of holes 26 drilled through the cone support housing 22 such that a curtain of cooling air is directed towards the lens 17. Preferably the equipment is maintained at ambient temperature.

The internal electrical resistance of the cadmium cell alters with variation of light intensity and the change of resistance can be measured using a bridge circuit, with a small mercury battery as power supply and a galvanometer.

The sodium interference filter is fitted bebetween filters 23 and 24 and into the annular tially eliminate light of other wavelengths. As the sodium filter does not completely eliminate light of other wavelengths, the photometer is used with clean air, the detector may provide an indication generally referred to in the art as a "clean flame indication" and the bridge circuit can be balanced for the reading, if any, obtained for this clean flame such that an increase due to sodium in the flame during normal operation can be read on the most sensitive range of the galvanometer.

It will be appreciated that no neutral density filters are required and by using a shunt across the galvanometer it is possible to obtain a reading of the concentration on the upstream side of the filter in an undiluted form without overloading the galvanometer. If readings go beyond the range of the galvanometer the bridge circuit can be switched out and a micro ammeter connected to the cell in a direct circuit to provide greater flexibility.

This arrangement is particularly advantageous since with the known conventional photometers the upstream aerosol is too concentrated to be fed directly to the flame and is generally diluted in a series of mixing vessels forming a calibration circuit before entering the burner.

The equipment is particularly suited for use with methane as the combustible gas but coal gas may also be used with advantage provided the coal gas is supplied under stable conditions of flow and pressure, i.e. from a cylinder.

WHAT WE CLAIM IS:—

1. A flame photometer comprising a hollow burner arranged to project into a transparent chimney, spaced inner and outer casings surrounding the chimney, means for supplying metered quantities of air and a combustible gas to the burner, means for supplying coolant to the space between the inner and outer casings, means to selectively introduce to said flame with said air and combustible gas a metered quantity of a sample of air containing a substance the quantity of which is to be measured, the substance when introduced to said flame causing the flame to emit light of one or more characteristic spectral lines, a lens adjacent the chimney, a photo electric cell cooperating with said lens to measure the light intensity of the flame through said chimney

and optical filter means disposed between the lens and said photo-electric cell for selectively passing one or more of said spectral lines to said light sensitive cell to provide an indication of the quantity of said substance in the sample of air.

2. A flame photometer as claimed in claim 1 wherein the said substance is sodium chloride.

3. A flame photometer as claimed in claim 1 or claim 2 wherein light guide means are provided between said lens and said photo-electric cell.

4. A flame photometer as claimed in claim 3 wherein the light guide means is formed from a solid transparent material which is frusto conical in shape.

5. A flame photometer as claimed in any one of the preceding claims wherein the burner comprises a hollow flat topped cylinder apertured in its upper surface and the air, combustible gas and air containing said substances are supplied through ducts to a mixing chamber connected to the interior of said burner and flows through the said apertures.

6. A flame photometer as claimed in claim 5 wherein a wire gauze is located internally below the said upper surface.

7. A flame photometer as claimed in any one of the preceding claims wherein said burner is centrally spigotted into a hollow base member and the lower end of a rectangular glass chimney is sealed to the burner and said inner and outer casings are secured to the base member.

8. A flame photometer as claimed in any one of the preceding claims wherein the coolant is supplied to the space between said inner and outer casings via a ring of supply ducts located in the outer casing and adjacent said lens whereby a curtain of coolant is directed towards the periphery of the lens.

9. A flame photometer as claimed in any one of the preceding claims wherein the inner casing is open at the top and extends above the chimney and the said outer casing extends above the inner casing and is provided with a light trap at its upper end.

10. A flame photometer substantially as hereinbefore described with reference to the drawing accompanying the provisional specification.

11. A flame photometer substantially as hereinbefore described for testing the efficiency of an air filter.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*